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ABSTRACT

An analysis of informal reasoning and examination of teaching practices looks at ways to improve reasoning skills in college students. Teaching students to reason more effectively is an important but difficult goal of higher education. Reasoning consists of complex skills which must be taught. Effective instruction is based on two key features: (1) a model that specifies the product of reasoning and the skills involved in informal reasoning; and (2) direct instruction of skills and close supervision and guidance of students during the acquisition of reasoning expertise. A distinction between formal and informal reasoning is offered. Most arguments college students encounter use informal reasoning. The structure of informal arguments is broken down into six essential elements (claims, grounds, warrants, backing, modality, and rebuttal). Informal reasoning skills and knowledge are explained in terms of analytical skills, evaluative skills, constructive skills, and topic knowledge. Common problems students have in informal reasoning include: underdeveloped mental models of argument structure, inadequate use of evidence, underdeveloped arguments, and errors in logic or faulty inferences. Teaching informal reasoning requires: providing students with a model of reasoning that clearly specifies the skills to be learned; organizing skills into a rough sequence based on their function and complexity; direct instruction of reasoning expertise; frequent opportunities to practice reasoning; and precise feedback. A suggested sequence for teaching these skills is outlined, its purpose is to teach students to analyze, evaluate, and construct informal arguments. Some complications of this teaching endeavor include the knowledge versus skills issue and the problem of transfer or generalization. Contains 13 references. (SM)

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The Nature and Development of Informal Reasoning Skills in College Students

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The purposes of this paper are to analyze informal reasoning and examine teaching practices that can improve reasoning skills in college students. Informal or everyday reasoning is involved in solving problems, making decisions and formulating beliefs. Teaching students to reason more effectively is an important, although difficult goal of higher education.

Reasoning expertise consists of complex skills. Students do not acquire expertise merely by engaging in tasks that require the use of these skills. Students should be taught how and when to use reasoning skills. Effective instruction is based on two key features:

1. a model that specifies the product of reasoning (i.e., informal argument) and the skills involved in informal reasoning.
2. direct instruction of skills, and close supervision and guidance of students during the acquisition of reasoning expertise.

The model of reasoning provides students with a clear goal, and teachers with a tool for diagnosing and correcting students' reasoning difficulties. Direct instruction involves clear descriptions and explanations of reasoning skills and coaching during skill acquisition.

Reasoning is a central intellective ability involved in solving problems, making judgments and decisions, and formulating ideas and beliefs. An important aim of higher education is to improve the reasoning skills of students and to encourage the development of a reasoning person. Reasoning processes are important not only for academic achievement but for effective everyday living as well.

The goal of improving college students' reasoning skills, however, is not always achieved. As educators our classroom experiences often provide discouraging evidence about the extent to which students learn to reason as a result of our classes and our teaching. Moreover, empirical research on the reasoning skills of undergraduates confirms our worst suspicions: too many students reason poorly, and worse yet, too many students continue to reason poorly even after receiving instruction designed to improve their skills (Perkins, 1986).

Teaching reasoning is a stubborn problem. It appears that simply assigning tasks and activities that require reasoning will not improve most students' abilities to reason effectively. However, some instructional practices are more likely than others to promote the development of reasoning skills. In effect, these approaches do two things. First, they operate on precise models of reasoning that clearly specify the skills to be taught. Secondly, they involve direct instruction that systematically guides students during the acquisition of these skills. Too often college teachers assume that students can "catch on" or figure out how to perform complex activities without substantial explanation and guidance. However, teaching college students to reason effectively is very much like teaching basic skills to younger children; the skills need to be clearly defined and the student needs systematic guidance in the acquisition of the skills. This paper addresses two concerns: what is the nature of informal reasoning and how can college students be taught to reason more effectively.

Informal reasoning. The term "reasoning" has been applied to many different cognitive activities ranging from making logical inferences, to evaluating syllogisms, to constructing and supporting beliefs. Although there is no perfect taxonomy for classifying reasoning processes, the distinction between formal and informal reasoning is useful.

Formal reasoning involves the derivation or formulation of arguments in relation to formal deductive systems such as mathematics or logic. Arguments consist of conclusions based on certain premises. The evaluation of formal arguments involves determining whether the conclusions follow from the premises according to the rules of the system.

In contrast, informal reasoning entails the analysis, evaluation and formulation of arguments based on reasons (Toulmin, Rieke & Janik, 1984). At the heart of informal reasoning is the claim-support relationship. Informal arguments are based upon claims that are supported by some kind of evidence. One makes an assertion and then builds a case for it by bringing to bear relevant and sound support, and by explaining the weaknesses of opposing claims. The premises of informal arguments can change with the addition of new information into the situation.

Most of the arguments college students encounter in academic work as well as in everyday life entail informal reasoning. For example, arguments related to the value and significance of a literary work, a psychology experiment, an economic theory, a social problem or decisions related to one's choice of a presidential candidate, career, consumer product or solutions to interpersonal or household problems all involve informal reasoning. Informal reasoning skills enable individuals to understand and critique the ideas and beliefs of others as well as to formulate their own ideas and beliefs. Again, these skills are important not only for academic achievement, but they can be applied in almost any domain of human experience.

The structure of informal arguments. In order to examine the nature of informal reasoning skills it is useful to distinguish between the product and processes of informal reasoning. The product of reasoning is an argument. Although different models of reasoning exist, I have chosen Toulmin's version of argument structure (1958; 1984) to use throughout this paper. Toulmin's model describes the six essential elements of informal arguments:

1. Claims- assertions or propositions believed to be true by the arguer. These constitute the arguer's position.
2. Grounds- the evidence that supports a claim. Grounds typically consist of observations, examples, data, testimony, previously established claims and so on.
3. Warrants- general laws, rules, statutes, and principles that connect or justify the relationship between grounds and a claim.
4. Backing- the general body of knowledge presupposed by a warrant. Backing demonstrates whether the warrant is reliable and relevant.
5. Modality- qualifiers that indicate the degree of strength or certainty and express the limitations of a claim or argument.
6. Rebuttal- conditions under which the argument or a claim may not be valid.

An informal argument consists of a claim or sets of claims supported by reasons. The reasons consist of grounds, warrants, backing. There is a chain-like structure to informal arguments in that a claim must be supported by grounds, which in turn must be logically connected to the claim by a warrant, which must be shown to be sound and relevant. In addition, an informal argument should specifiy its own limitations and the conditions under which it may not hold up. Figure 1 presents a simple example that describes the relations among these components.

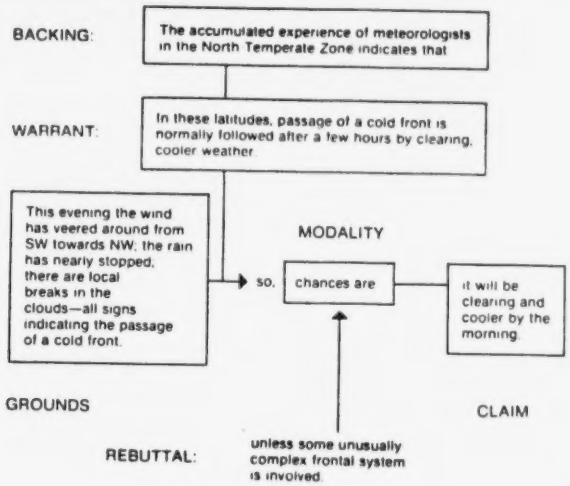
BACKING:
The accumulated experience of meteorologists in the North Temperate Zone indicates that
WARRANT:
In these latitudes, passage of a cold front is normally followed after a few hours by clearing, cooler weather
This evening the wind has veered around from SW towards NW; the rain has nearly stopped; there are local breaks in the clouds—all signs indicating the passage of a cold front.
MODALITY
so,
chances are
it will be clearing and cooler by the morning.
GROUNDS
CLAIM
REBUTTAL:
unless some unusually complex frontal system is involved.

FIG. 1 Toulmin's "Structure of Argument"

Obviously, more complex issues than the one presented here will result in more extensive arguments. But, the model, although relatively simple, captures the essential features of informal arguments. Toulmin's model is useful because it provides a description of the "ideal" product of informal reasoning, a goal towards which students can work. Students can model their own arguments on this structure. It also provides a tool for the classroom teacher who can help students advance towards the goal, or "ideal." The model can be modified to fit different disciplines. The basic stucture of informal arguments may be similar across many disciplines whereas the kinds of evidence that are most appropriate may vary from one discipline to another. For example, an argument on an issue in psychology is likely to contain relevant experimental evidence in contrast to an argument in literature which is unlikely to have or need this kind of empirical evidence.

Informal reasoning skills and knowledge. An argument is the result of reasoning. Reasoning consists of the particular skills and processes involved in analyzing, evaluating and constructing arguments. Several categories of skills and knowledge are

necessary for effective reasoning. These include:

1. Analytical skills. The student must be able to identify the components of arguments. The student should be able to distinguish the claims, grounds, warrants, backing, qualifiers, and rebuttal in arguments.

2. Evaluative skills. The student needs to know and apply criteria for judging the quality of arguments. Students must be able to determine whether:

A. the claims are clear, and grounds are relevant and sufficient in support of them.

B. the warrants are relevant and adequately backed.

C. the stated conclusions take into account possible exceptions and counterarguments.

3. Constructive skills. The student must be able to generate, integrate and organize lines of argument on both sides of an issue. This entails stating and qualifying claims, bringing to bear appropriate support for those claims and noting the limitations of the position.

4. Topic knowledge. The student must have "sufficient" knowledge of the topic or issue in order to analyze, evaluate or develop an argument.

These skills are stated in general terms without reference to particular fields of study in which they take on more specific meanings. In addition, each category might contain many specific skills or procedures. For example, in order to evaluate whether the grounds in an argument are adequate one must be able to determine whether the information provided is sufficient, clear, verifiable, internally consistent, current, the best available and so on (Toulmin, Rieke, & Janik, 1984).

Students' difficulties in informal reasoning. The model of argument structure and informal reasoning skills are useful diagnostic tools for identifying students' problems in informal reasoning. The model represents an "ideal" argument structure, and students' arguments can be judged against the model with some degree of specificity. The following are common categories of problems that students have in informal reasoning:

Underdeveloped mental models of argument structure. Students vary in what they know about the structure of arguments. The most naive students equate arguments with opinions. These students analyze and evaluate arguments by merely summarizing an author's ideas, and in their own "arguments" make unsupported claims, seemingly unaware that support is necessary. Consequently, their arguments merely express

opinions and preferences for particular ideas. The source of their problem is the failure to recognize the claim-support relationship. Researchers in epistemological development would label these students as "dualists", who believe that issues have either a "right" or "wrong" answer and that the truth is self-evident.

Other students know more about argumentation but still do not have a complete mental model of argument structure. They may recognize that it is important to substantiate assertions but fail to recognize that it is important to consider counterarguments. These are students who have neither learned nor been expected to use these distinctions in their previous academic work. Thus, students' reasoning may be inadequate because they do not have a well-articulated mental model of argument structure.

Inadequate use of evidence. I believe that most college students know that claims or generalizations must be accompanied by support; however, many students do not know what counts as appropriate support or how to use support skillfully. For example, I have noticed a strong tendency among students in psychology courses to rely on personal anecdotes to support their claims even when they have access to better evidence. Although anecdotes are inappropriate evidence in these courses, they may be perfectly acceptable in other situations. Students are often unclear about what constitutes "good" evidence (i.e., data, examples, principles, statements by authorities).

Their lack of rhetorical sophistication probably stems from the varying expectations they experience across the disciplines. Disciplines differ in what counts as valid support for arguments, and individual teachers vary in what they will accept from students. If students are not taught explicitly about the kinds of support and evidence appropriate for each field they study, they may never achieve an ability to use support skillfully.

In fact, the inconsistency that students perceive can lead to the pernicious belief that teachers' evaluations are arbitrary, and that a good argument is simply one that the teacher "liked." According to researchers in epistemological development, "relativists" are those who believe that all arguments and opinions are of equal value. There is good reason to suspect that higher education helps to create relativists by failing to teach students what counts as appropriate and sound support for arguments.

Underdeveloped arguments. Perkins (1985) uses the term "make-sense epistemologists" to characterize students who produce underdeveloped arguments. These college students provide relatively few reasons to support their claims and give little or no consideration to counterarguments or conflicting evidence. Although they can provide appropriate evidence, make-sense epistemologists fail to go far enough. Their arguments are one

dimensional, unbalanced and superficial.

I have found this to be a prominent problem among my own students, and I think that there are two primary reasons for it. One is the student's belief that a plausible argument is good enough. Again, the student's mental model of an argument is discrepant from the "ideal" model of argument. In this case the student lacks adequate criteria for judging the strength of an argument. These students may be quite capable of developing better arguments (i.e., more reasons on either side of the issue), but they do not see any need to do so.

College students also produce underdeveloped arguments because they lack content knowledge of the issue or topic. Quite often students are in the difficult position of analyzing or constructing arguments on unfamiliar topics. Research in cognitive science is unequivocal on this matter; well-organized content knowledge is a necessary prerequisite for effective reasoning. Obviously, if one knows little about a subject it is nearly impossible to have a well-developed position on it. However, the problem is deeper than this. Even when students do have access to relevant information they still confront the formidable task of trying to learn and gain sufficient control over that knowledge in order to use it in reasoning. Sometimes an underdeveloped argument reflects more accurately the limits of what a student learned about a subject rather than particular reasoning deficits.

Errors in logic or faulty inferences. "Faulty" reasoning involves logical errors or inappropriate inferences. Philosophers have identified many different types of formal (e.g., affirming the consequent or denying the antecedent) and informal fallacies (i.e., ad hominem) in reasoning. However, studies of informal reasoning find that these formal and informal fallacies do not appear very often in students' informal arguments (Perkins, Allen, & Hafner, 1983). Instead, most reasoning "errors" result from a failure to explore the consequences of claims or reasons. In effect, students find it difficult to be a critical audience for their own ideas. One common problem is that of "contrary consequent" or arguing from A to B when it is just as plausible to argue from A to not-B. For example, in an essay on improving the quality of public education my students often argue that teachers should be paid more. They reason that this will attract better qualified people into the profession. Rarely do they consider that higher salaries will attract more unqualified people as well (For a more extensive discussion of errors in informal reasoning see Perkins, Allen & Hafner, 1983).

Development of informal reasoning. Learning to reason effectively is very similar to learning to play a complex game such as baseball. Both require mastery of a large number of discrete skills (e.g., identifying claims and evidence; fielding ground balls and batting). These, in turn, also vary in complexity (i.e., some are straightforward and others much more difficult). In addition, both reasoning and baseball adhere to a set of rules that govern the structure of the game (e.g., explore both sides of an issue; three strikes and a batter is out).

Informal reasoning involves the development and orchestration of a set of complex mental skills. The development of reasoning expertise takes time and practice. Learning to reason, probably involves three phases of skill acquisition:

A. Novice- Initially, students must learn the basic components of arguments and the processes of reasoning. Execution of these skills is halting, deliberate and rigid. The student typically has poor control over both knowledge and skills. Developing even simple arguments is a struggle because the student must deliberately think about each separate part of the process.

B. Intermediate- Students at this point have internalized a model of argument structure and have practiced reasoning skills enough to be able to run them smoothly in many situations. The student now possesses a mental model of well organized reasoning knowledge and routines that can guide performance on reasoning tasks. However, the student's arguments lack a unique style, and still resemble the concrete models that he or she originally learned. Moreover, the student may regress under certain conditions, and produce underdeveloped arguments. This is likely to happen when the issues are especially complex and unfamiliar. The student at this point might be compared to a technically proficient musician who has a small number of pieces in his or her repertoire.

C. Expert- Experts' arguments are relatively error-free. They are able to apply reasoning knowledge and skills effectively and adapt these to specific task demands. The individual is adept at evaluating and producing effective, sound arguments. The individual may even develop a unique style of arguing. It remains a question, however, about the extent to which the expert can reason equally effectively across fields of study. Research in cognitive psychology provides substantial evidence that well organized content knowledge is crucial for effective problem solving, and skills are often domain-specific rather than general (Hayes, 1985). For example, Voss, Greene, Post, & Penner (1983) presented social science problems to research chemists and found that their solutions were more like those of novices (i.e., undergraduates) than experts (i.e., social scientists). The

chemists, although excellent problem solvers in their own discipline, lacked both the content knowledge and specific skills necessary to tackle a social science problem.

Typically, students enter our classes as novice reasoners. They do not have well-articulated mental models of argument structure or reasoning strategies. They have had few experiences in analyzing, evaluating or actually constructing arguments. And, even when they have had previous experience (e.g., writing persuasive essays in composition courses), they are still naive about the particular assumptions and procedures of argumentation used in different disciplines. In addition, they usually lack extensive knowledge of the topics about which they must reason. These conditions create a difficult instructional problem. Given these conditions, how can we help the novice to acquire reasoning expertise?

Teaching informal reasoning. Two closely-related teaching models are particularly effective for teaching reasoning skills. These are "scaffolding" and "coaching." Scaffolding involves close supervision and guidance of novices (i.e., students) by experts (i.e., teachers). The teacher aids the student by focussing the student's attention on the parts of complex tasks that need improvement, and by giving specific information about how to improve these. Students receive just enough help to keep them advancing towards a goal (For excellent examples of scaffolding see Palincsar and Brown, 1984 and Palincsar, 1986). Perkins (1986) used a scaffolding procedure to improve students' informal arguments on vexed issues. In this procedure teachers worked with students as they generated a position on an issue. During the interaction, teachers asked questions or gave directions designed to get students to improve one or another aspect of their arguments. The procedure was effective in increasing the number of "myside" and "otherside" reasons students generated for an issue.

Scaffolding is similar to coaching. During coaching, players receive directions about how to perform a skill and then receive precise information about their performance (i.e., what they did well and what needs to be improved). Good coaches can diagnosis both strengths and weaknesses in players' performance, and describe what players need to do to improve. Coaching, like scaffolding, helps students move systematically towards difficult goals.

The procedures used in scaffolding and coaching provide excellent models for teaching students to reason more effectively. The important elements are:

1. providing students with a model of reasoning that clearly specifies the skills that students must learn.

2. organization of skills into a rough sequence based on their function and complexity. For example, it makes good sense to learn to analyze arguments before learning to evaluate them. Trying to learn and do these simultaneously presents a confusing task for the novice.

3. direct instruction of reasoning expertise. Direct instruction involves descriptions, explanations and demonstrations of how and when to use reasoning skills.

4. frequent opportunities to "practice" reasoning.

5. precise feedback to students.

Below I have sketched a sequence for teaching reasoning skills and a set of guidelines that take into account the nature of reasoning processes and their development.

Teach students to analyze informal arguments. The instructional goal is to teach students a model that specifies the components of arguments. Students should eventually internalize this model and be able to identify and explain the components of arguments they read.

Teach the components directly in class using several examples of relatively simple arguments. Give students extensive practice with a range of examples. If this sounds too pedestrian, just try it. I will never cease to be amazed by the number of students who initially cannot even identify an author's major claims. Moreover, many students confuse an author's claims with the counterarguments discussed by the author.

Teach students to evaluate informal arguments. The instructional goal is to teach students a set of criteria for judging the quality of informal arguments. Students should eventually internalize these criteria, and be able to use them to evaluate arguments they read.

I advocate directly teaching a prescribed set of criteria to students. Even though this procedure involves rote memorization and rigid application, it is important to remember that students probably have no criteria for evaluating arguments in our disciplines. In addition, they have had little experience actually evaluating arguments in a systematic way. As they become more experienced, students may begin to use these criteria more flexibly and modify or refine them to fit different situations and tasks.

There is some benefit to having students evaluate arguments they previously analyzed. Since they are already familiar with the components of those arguments, they can focus exclusively on evaluation. Moreover, the teacher can also use these to illustrate strengths and weaknesses in form, organization, style and so on.

Teach students to construct informal arguments. The instructional goal is to teach students to develop well-reasoned informal arguments. The student must be able to select and generate ideas, assemble and relate evidence, and organize their ideas coherently. During this process they also need to be able to criticize their own products.

Producing a sound argument is a much more difficult task than analyzing and evaluating someone else's. However, the student's analytical and evaluative skills should serve as a guide in the process of learning to construct sound arguments. Essentially, their mental models, which specify the structure of arguments and criteria for evaluation, should enable students to better judge their own products. Without this knowledge students would be completely dependent upon teachers to correct and guide them, and teachers almost never give all the specific feedback that students need to improve their work.

Even when students have become adept at analysis and evaluation, the task of developing an argument is still beset with the difficulties associated with any complex writing task. Essentially, students must juggle several tasks at once; learning about the subject, employing appropriate reasoning skills, and working ideas into acceptable text. It is important to recognize that the novice can be overwhelmed by trying to integrate these activities simultaneously. Good coaching or scaffolding aids the student by holding some constraints constant (e.g., ignore grammar and punctuation in early drafts) so that the student is free to concentrate effort on other parts of the task (e.g., generating claims and appropriate support).

Several general guidelines can help the classroom teacher control various parts of the learning process for the novice reasoner.

1. Selection of materials and topics. Teachers should select background materials for novices. The reason for this is simple. If students know very little about a topic they do not have the necessary criteria to select appropriate readings for the topic (i.e., they do not know who is a reputable source or which sources represent the most current knowledge on the topic). In addition, instructors should consider such factors as the complexity of the topics and issues, students' prior knowledge of the topics and the amount of experience students have had in reasoning. Teachers should think carefully about what topics are most suitable for novices (i.e., do students have the background to even approach the subject intelligently) and whether the topics are sufficiently compelling to motivate student interest in them. Finding appropriate materials can make or break one's attempts to teach effective reasoning skills. Obviously, the best materials are those that individual teachers select and refine through use. (There are some published materials that are

organized around a debate format that can be useful in introductory level courses (e.g., Taking Sides by Dushkin Publishing and Opposing Viewpoints by Greenhaven Press).

2. Argument format. Provide a simple organizational scheme for students to use (e.g., compile all the evidence in favor of a position then all the evidence opposed). This provides a structure into which students can fit their ideas, without their having to be overly concerned about what the structure ought to be.

3. Examples. Provide examples of other students' arguments. Students are often interested in examining their peers' work. Papers that are carefully marked to identify their strengths and weaknesses give students concrete ideas about what they should produce. However, unmarked papers provide little concrete or direct information to students, and leave students guessing about the specific differences between a good and a poor paper.

4. Evaluation and feedback to students. Constructive feedback to students is, perhaps, the most important feature of teaching reasoning skills. Novices, especially, need to be told precisely what they have done well and what should be improved upon. Until students can function as effective critics of their own work they should have frequent opportunities to practice and receive feedback on their work.

Most college teachers recognize the importance of giving feedback to students, but not all teachers do so effectively. Evaluating students' work is labor intensive, and to evaluate with care, precision and frequency can be a burden. However, students can only benefit from feedback that makes sense to them. For example, the student with only a shaky understanding of the claim-evidence relationship is hardly in a position to make use of teacher comments such as, "weak evidence" or "spurious claim". To the student these are cryptic remarks with almost no informative value. Teachers need to think carefully about what students needs to know in order to improve their ideas. This task is much easier if students have already internalized the model of argument structure. Teachers can then respond with precision using a language that students understand.

Peer review can be a helpful way to provide more feedback to students. Obviously students vary in their ability to evaluate arguments, but if teachers structure the review process carefully, peers can provide useful feedback to one another. For example, reviewers might be required to identify a small number of well developed ideas and weaknesses and then make several specific suggestions. Or, teachers might give reviewers a specific set of criteria to use in their evaluations. Most students are capable of this kind of limited evaluation.

5. Revision. Students should have the opportunity to revise their arguments. Revisions can lead to better arguments, but students tend to tinker with form and neglect content. Students should be taught to revise both form and content.

Teachers who require revisions understand the strength of student resistance to the task. Yet it is essential that students gradually adopt the view that good ideas are shaped and molded; that ideas change during the course of thinking about them. I have not discovered a sermon that quickly converts students to this view. However, I do think that students are more likely to move in this direction if:

A. they have been asked to think about important ideas.

B. their ideas have been treated with respect.

C. they believe that the teacher is really concerned about their progress.

D. they can identify the progress they have made.

E. they receive feedback prior to grade evaluation.

F. their revisions actually contribute to a better grade.

In summary, the student enters the enterprise of reasoning much like the apprentice enters a trade. As a novice the student has little formal knowledge of or experience with the tools of the trade. The students' first pieces will be rough and unpolished. The student sets out on a long developmental course, acquiring expertise under the guidance of a craftsperson. The expert needs to select and teach the skills in a systematic way, giving the student ample opportunity to acquire and refine the skills and make and remake their ideas.

Larger issues, caveats and serious doubts. Although I remain firmly committed to the goal of teaching students to reason more effectively, I recognize the limits of what I can do as a classroom teacher. There are formidable obstacles looming at every level of this endeavor.

Knowledge vs. Skills. Even teachers who are converted to the "thinking skills movement" wrestle with the issue of how to integrate skills instruction without sacrificing content knowledge in courses. After many bouts with this problem, I have assuaged my own conscience on the matter. It is not possible to cover the same amount of content knowledge and also do skills instruction effectively. Even when skills are integrated smoothly into the course, content must be sacrificed. However, the real question should be, How much did the students learn? and not, How much did the teacher cover? Students forget most of the factual material they learn from lectures and from texts. You can convince yourself of this by asking students to describe or explain concepts they learned

in previous courses. For example, in one of my classes recently, I asked students to explain the Krebs Cycle which most had learned in general biology. No one was able to explain the concept. In fact, no one remembered anything about it.

Students learn material more thoroughly when they have a purpose and context for knowing it. Knowledge that is learned in the context of or in service to some useful purpose will be better remembered. The purpose might be to develop an argument or position in which the information becomes important. Thus, students may learn more, while covering less, in a course that teaches them important intellectual skills and involves them in active learning.

The Problem of Transfer or Generalization. Even if my instruction has a salutary effect on students' reasoning skills, what happens after they leave my class? A very likely possibility is that students never again use the skills they learned in my class. This may happen for several reasons. First, one semester of instruction and practice in reasoning does not produce a highly skilled reasoner. One course does not have much long-term effect. Secondly, even when students learn to use particular skills, they fail to use them in new situations where they would be appropriate. It is very difficult to promote the transfer of skills to new contexts. Lack of transfer is a well-documented phenomenon, and poses a difficult problem to educators who want to have a lasting effect on the reasoning expertise of their students. Thirdly, the skills that students learn in one class may not be fully appropriate in another class or discipline. Many skills may be domain-specific and applicable to only a small range of problem types. Thus, students may not understand how to adapt what they have learned to new situations.

Caveats and Serious Doubts. It is thrilling to watch individual students progress during a semester. But, I recognize that there are serious limitations to what I can accomplish as an individual instructor. Teaching reasoning is similar to teaching writing. Students learn to write better as a result of one or two English composition courses. However, they remain novices; most do not write well. They may learn to write well if they are taught to write and expected to write well in most or all courses. Similarly, students will not learn to reason well in one or two courses, but they may improve significantly if many of their college courses are organized around this goal. This requires a reasoning across the curriculum approach in which many faculty adopt the same goal. It is important to teach college students to reason with care, precision and depth of understanding. But, this will only come about as the result of a programmatic effort by faculty across and within disciplines.

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